

## VISION, A COMPONENT OF LOCOMOTION <sup>a</sup>

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After having been concerned with physical correction of blind people for some months it was felt by the author that standard methods of posture correction were giving very poor results. While there are many successful blind people in all countries, when it comes to helping their fellows who fail to reach this standard through physical insufficiency, published methods of assisting them are rare. It was argued that postural inadequacies connected with blindness are a dynamic problem; therefore, an analysis of visionless locomotion might be the first step in determining whether vision has any direct involvement with the mechanics or development of bipedal gait, and whether divergencies of posture and gait in people with completely haptic minds follow any consistent pattern.

The subjects studied in detail were 14 congenitally totally blind students aged 12 to 18, and two children aged six. Only two had light projection and a little color vision; all except one child were of good intelligence, and had been selected for mobility training and correction because they could not yet hold their own in an unsheltered situation either in school or employment.

Since I was involved also in physical education, blind athletics, and outings, the problem of motion in blind people of all ages was analysed and grappled with daily in a functional situation throughout the two years of the study. The posture and gait of workers in the sheltered workshop were also observed, but no blind adults who were established in society were available for study. The mobility training given to the 16 subjects was the Hoover technique with a long cane, and instruction in orientation. The staff had been trained by R. E. Hoover himself. The posture correction was given in connection with this training, and it was soon realized that the special cane played a big part, for when gaits were first analysed, none of these subjects was able to walk fast enough, without being led, to make a true assessment; if external guidance is given, the balance and neurological patterning is different. Also at this stage, the

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mechanical problems were masked by tension and lack of confidence. It took usually two, but up to six, months of training before the nervous element disappeared sufficiently for a valid mechanical assessment to be made. The success of this cane and technique prompted us to inquire whether, as a device, it fulfilled any prosthetic function, and if so, how?

### **MECHANICS OF COMPENSATION**

To sum up a recent analysis of normal human locomotion (2), one forward step consists of two phases: supporting phase, further divided into heel-strike, mid-stance, and push-off; and swinging phase, comprising acceleration, swing, and deceleration. During the step the center of gravity of the body moves forward in a double sinusoidal curve contained within a 2-in. square, and the muscle work is organized to control this path and smooth out the curve, to as near a straight line as is consistent with adequate speed and function; a 2-in. deviation from the straight line being the minimum possible for a normal gait. The forward and upward movement in the sinusoidal curve is powered mainly by the calf and hip extensor muscles, and for the forward and downward movement the force is gravity and momentum. This is the crux of the whole problem of defective vision, for during this downward movement of the center of gravity, the muscles work only as shock absorbers and decelerators, and in order to avoid loss of balance, the postural reflexes in which they take part must be perfectly timed, in response to sensory intake. To quote Joseph (3): "The early part of the supporting phase is the means whereby loss of equilibrium is prevented. If the heel were not placed on the ground at that precise moment one would fall over, because the center of gravity of the body is now in front of the opposite supporting limb."

The eye is the only sense organ which enables man to react in time to be certain that a well-timed heel-strike will restore his balance at just the precise moment Joseph describes. The gait of a blind man tends to become unsteady, because sight is an important part of the sensory side of the balance system. Vision also is the main long-range stimulant of the protective reflexes, and therefore a blind man has little hope of activating them in time to save himself from obstructions. Loss of vision affects the gait mechanically in three ways: loss of sensory data necessary for timing the steps; impoverished balance; deficiency of protective reflexes.

Mechanical compensation must start the minute a blind baby walks erect. It is interesting here to note that during the amphibian and quadruped stage in both animal and child, vision plays no part in the mechanics of slow locomotion, because by moving one foot at a time, the center of gravity remains always over the other three legs. Only the higher animals with more complex eyes and nervous systems take risks with their balance to increase speed or free the hands for other things.

It is possible that there is no mechanical change in the development of a blind child's locomotion at the crawling stage, and only inhibitions in the early stages of erect walking, because in the flat-foot, broad-base, hand-clutching, normal infantile gait there is little threat to the equilibrium. The gait of an adult blind man is, however, mechanically adjusted to achieve two ends: 1. to reduce or abolish the phase of lost equilibrium from the step, thus flattening the curve of the path of the center of gravity; 2. to keep the center of gravity over the supporting limb until the leading foot can be stretched out to substitute for the eye in reconnoitering the ground ahead. But none of this is possible without completely destroying the mechanics of a normal gait, and the results of such compensation are as unsightly and detrimental to posture and development as would be compensation for a grossly shortened leg, if this were allowed to proceed without prosthetics or guidance.

Compensation for any mechanical fault in gait is brought about by interplay of the six basic determinants of gait (2): 1. pelvic rotation; 2. pelvic tilt; 3. knee flexion in stance; 4. foot and ankle movement; 5. knee motion; 6. lateral motion of the pelvis. And to flatten the path of the center of gravity and reduce the threat to equilibrium, I believe the following takes place: a. an increase of knee flexion in stance (3); b. rearrangement and drastic reduction of foot and ankle motion (4) so that heel-strike can take place with the foot flat or plantar flexed and at push-off so that the rise of the ankle can be considerably lessened; c. further interplay of knee motion in relation to foot and ankle motion (5). All of these adjustments add up to a reduction of momentum and of all factors causing the center of gravity to rise; d. an increase of pelvic rotation is seen only in subjects who have achieved a high degree of compensation, for this facilitates the lengthening of the stride without increasing the drop of the center of gravity.

Other mechanical adjustments may be made, such as the shortening of the stride to as little as one foot-length, which means that the gait mechanically resembles a wheel and the center of gravity travels in a dead straight line. In order to reconnoiter with the foot without loss of balance, an excessive backlean of the trunk develops with a compensating poke of the head. Figures 1 and 2 show the compensation of a 16-year-old and a 15-year-old, both of normal intelligence. Figure 1 shows a boy with a functionally efficient speedy gait, with pelvic rotation increased until it appears as a wriggle. No matter what hazards this boy meets he never falls forwards, but sits backwards neatly catching his weight on his hands. Note the distribution of the weight over the feet, the position of the leading foot, the unusual arm position for a gait of this speed, neither hand being behind the hip joint, the back-lean, dorsal kyphosis, and rigid carriage of the head which is the very best he can do to correct his poking head. He



FIGURE 1.—Fully compensated functional blind gait, with gross postural problems.



FIGURE 2.—Non-functional compensation with developing deformity.

is outgoing and energetic, but his appearance is a disadvantage to him. Figure 2 shows a girl who has reduced all motion to a minimum. The gait is scarcely functional at all, being a short-step wheel-like motion. The posture is rigid to a point where secondary-degree flexion contractures of joints are beginning. The girl is tense, intensely nervous, and withdrawn.

### POSTURAL AND NEUROLOGICAL EFFECTS

From the foregoing it is obvious that the blind child must from the start develop abnormal postural reflexes and motor patterns to cope with the necessary mechanical adjustments. Others will believe with Barlow (4) that faulty mechanics are not the primary cause of poor posture. He states that all posture and the correct distribution of body tension primarily depend on the correct management of the head and neck, retraction of the head being the most basic cause of postural defects. He states further that the head should dominate and initiate all total behavior patterns, for when partial patterns gain independence of action, possibly as the result of stress, disease or civilization, disruption of the mechanism of total integration occurs. This causes conflict in behaviour patterns. Cephalization is bound up with the congregation of almost all the most important sensory equipment in the head. In the blind, perhaps as much as half of the total sensory intake normally received in the head is lost, or is compensated for in other parts of the body. The disruption of the mechanism of total integration is very obvious in the blind, stress and sensory loss

in the head area being the main reason why other parts of the body, notably the feet, play an abnormal sensory role, and also take over the initiation of behavior. This prevents the formation of good postural habits and smooth patterns of locomotion. Gesell (5) describes this in another way: "Postural behavior in a broad sense is the most fundamental concept for interpreting the integrity of the machine and the efficiency of its operation. . . . Locomotion is a dynamic repetitive projection of posture." The consistently poor posture of the blind points to neurological disintegration. The mechanist explanation of the locomotion problem given earlier need not, I believe, conflict with Barlow's vitalist theories of posture. In the blind it would seem that the two factors aggravate each other in a spiral.

With these theories in mind, it is interesting to observe the many neurological and postural abnormalities of blind children, particularly as they relate to the formation of gait patterns and postural reflexes. Repeated unpleasant incidents and falls, or over-protective parents, may prevent the child from developing a mature independent gait-pattern at all. This type of child soon becomes the victim of nervous tension, which shows itself in purposeless movement, fidgeting, rocking, and blindisms. But in those who form a reasonably efficient gait, appearance and smooth operation take second place to self-preservation. And because impoverished sensory intake affects the formation of adequate protective reflexes, the blind child must at best live in the anxiety state which keeps withdrawal and defense reactions constantly at the alert. If Barlow's hypothesis (6) is correct—"that there is an inevitable linking of muscular mechanisms with emotional states"—then the blind child must produce out of this anxiety the neuromuscular tension which Barlow states destroys the action of the proprioceptive organs in the muscle spindles. Thus the child's sensory intake would be doubly reduced, and further psychosomatic postural defects would result. It is noticeable, when teaching physical skills to blind children, that their awareness of body position and their body image is much more faulty than would be the case in a blindfolded normal child.

Further examples of abnormal neurological function can be found in blind children; a bizarre incoordination of gait, which could be described as a "visual ataxia," develops in many. Some are subject to excessive purposeless or misdirected movement. Others suffer from "freezing" (Fig. 3)—rigid inability to change position at all—clearly a psychosomatic phenomenon as it is precipitated by the impulse of fear, which Barlow (7) says is always associated with a retraction of the head and a stiffening of the arms and legs into the body, movements which negate any integrated action and predispose postural faults.

Another unsightly incoordination is the absence or abnormality of contralateral trunk and arm movements in the gait. These are usually



FIGURE 3.—Freezing, the somatic expression of fear.

present to balance the weight of the swinging leg and lengthen the stride, particularly in fast walking. For the slow stable gait of a blind child these patterns are, perhaps, scarcely a necessity, but when he eventually learns to move more quickly the pattern does not change. Observation was made, over a period of months, of 20 congenitally blind children and young adults, and in not one case was a normal contralateral trunk and arm movement present before training and correction. The correction was entirely directed to gaining relaxation, release of tension, and speed of gait, for it was assumed that the absence of arm swing was an inhibition, connected with fear. The patient's attention was never drawn to the arm swing until a rhythmical contralateral movement had occurred spontaneously. The training was successful in every case, though the time necessary varied from weeks to months.

These observations combine to show that vision plays a much larger part in the maintenance of neurological integration than is casually supposed, and that the disrupting forces of blindness on this system show up blatantly in posture and locomotion.

### DEVELOPMENT EFFECTS

It is interesting to compare the development of locomotion in the blind with the norms set out by Gesell (8). He lists 12 characteristics of infantile walking during the phase before mature locomotion is established. They are:

- (1) elevation of the arms;
- (2) little or no contralateral swing;
- (3) inability to balance on one leg;
- (4) walking with a broad base;
- (5) lowering of the center of gravity;
- (6) high stepping;
- (7) short stepping;
- (8) uneven stepping;
- (9) out-toeing;
- (10) full-sole stepping;
- (11) thrusting forward with the head and upper trunk;
- (12) using a leading hand for stability.

Twelve totally blind children between 11 and 17 years of age were observed over a period of months and checked in various situations where they could walk without inhibitions. None was without any of the above infantile faults, while some seemed to display them all, six being about average. One heavily built girl of 13 moved perfectly at a developmental level of 18 months, presenting, of course, a ludicrous picture. The ability to stand on one leg was tested with a larger number of children, and it was found that only one could balance for 20 seconds, a few for 8 to 10 seconds; the average was 3 to 5 seconds, and several could not stand on one leg at all. Another comparison was made between the two totally blind children in their seventh year, a time when adult locomotion should be well established in a normal child (Gesell (8)). One was blinded as the result of a tumor in the third year, the other was born without sight. When led by the hand, as is normal for a child of this age, the adventitiously blind child, although mentally retarded and emotionally disturbed, had an appearance and gait within the range of normal. The congenitally blind child, although intelligent and happy, had many postural faults: he often went into a frenzy of purposeless movement involving the whole body, and he appeared neurologically disintegrated in that none of his movements was consistently and smoothly organized toward getting over the ground. No consistent pattern of locomotion had been formed at six years of age. Normal adult locomotion should be established by the fifth year, says Gesell (8), and it is during these early years when the cerebellum grows almost to its full size that the patterns of gait are formed. Observation seems to indicate that a person blinded after the sixth or seventh year quickly reverts to a normal gait, even years later, as soon as sufficiently safe surroundings are guaranteed. But though with training the gait of a mature congenitally blind man can be improved, it is a slow job and very unrewarding.

## ORTHOPEDIC DEFORMITY

One can make a valid list of the common orthopedic deformities found in blind people because they occur with such consistency: flat feet; valgus feet with a broad-base, out-toeing gait; limitation of extension of knee and hip; hip-sling; dorsal kyphosis; poor muscular development of the shoulders; poking and retracted head. Formerly a study of this kind might have started with such a list; today its place is last, as deformity is merely the symptom and result of the mechanical and neurological abnormalities already discussed. It will be noticed that all of these postural defects occur in an anteroposterior direction, which is no accident as all the mechanical adjustments in the gait of the blind are concerned solely with altered control of the forward movement of the center of gravity. It seems that lateral deformity is no more common in the blind than in the sighted.

Poor muscular development of the legs and deformities of the feet are an almost universal characteristic of the blind. A glance at electromyographs of normal gait shows that the main action of quadriceps takes place following heel-strike, to check the fall of the center of gravity, but as described above, this fall is largely eliminated in the blind. Joseph (3) also states in his text that the action of quadriceps varies considerably in different gaits, its action in slow walking being very slight, but that similar variations in hamstring performance were not recorded in different gaits. The gastrocnemius makes its main contribution at mid-stance and before push-off to raise and propel forward the center of gravity, but, as previously discussed, this action is drastically reduced. This shows that the two main antigravity muscles of the leg never perform half their potential, while the flexors probably withstand a normal load—facts which must lead to an imbalance of muscles which would favor deformities of weakness and flexion.

The common valgus and flat foot of the blind could derive from out-toeing to gain a broader base and more stable balance; but as Lettin (9) says, "the flat feet of childhood are due to a temporary muscle imbalance," one which perhaps the blind child does not out-grow, the flat feet being retained along with other characteristics of infantile gait already described. But anyone who has seriously observed blind and partially blind children trying to run will soon see that a valgus position of the foot is not confined to the stance phase. This and the knock-kneed appearance is even more marked in the swinging phase, which leads into a heel-strike in an everted position. As already discussed, to compensate for blindness the pelvis rises less than normal during the step, so this must increase the muscle power required in the leg to clear the swinging toe from the ground. Holding the swinging foot in a valgus position is, I believe, an attempt at circumduction to ease this strain.



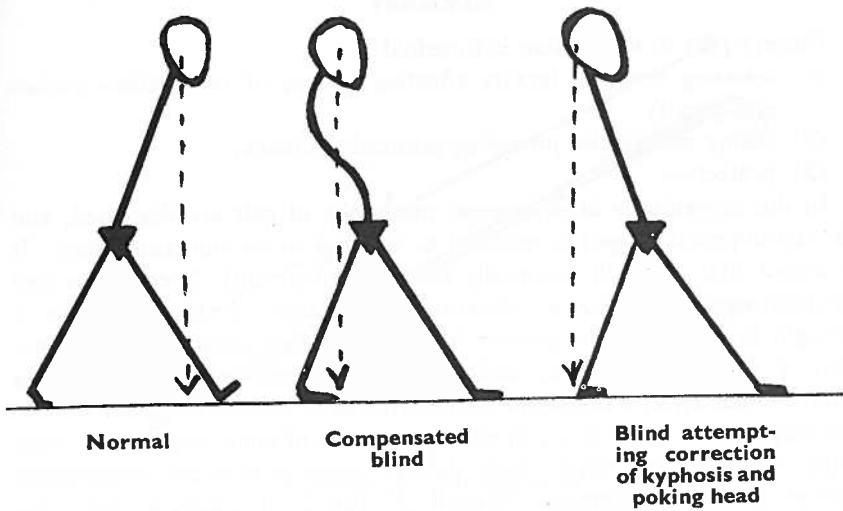


FIGURE 4

When considering trunk and head deformities, these must be thought of as compensatory to pelvic movement, particularly in the blind, as the legs take an abnormal part in initiating total movement pattern. Trunk movement and extension of the opposite shoulder balance the increased pelvic movement of a fast gait (3). So the slow, short-stepped gait of the blind predisposes poor development in the shoulders and trunk. Dorsal kyphosis and poking head follow from the back-lean of the trunk, which allows the leading foot to reach the ground while the weight is still over the supporting leg. If the head continues the line of the trunk, the person tends to over-balance backwards, or at best the head is held at such an angle that the neck flexors work isometrically against gravity, which is most uncomfortable (Fig. 4).

A consideration of these concepts must convince anyone who strives to correct these deformities of the futility of the whole range of orthopedic appliances, or exercises for strengthening specific muscles. The physiotherapist who tries to correct a blind person's poking head, as an isolated condition, does him a disservice because she is destroying the compensation to his real handicap. The blind person anxious to correct his head position usually acquires a tense, unnatural carriage (Fig. 1). It is not until we think in terms of prosthetics for vision's function in the gait, and reeducate a new postural pattern in which the head dominates, that mechanics can be normal or deformity correctable.

### SUMMARY

Vision's part in locomotion is threefold:

- (1) assessing external factors affecting timing of heel-strike—friction and gravity;
- (2) aiding balance by providing postural feedback;
- (3) protection.

In the congenitally blind, normal mechanics of gait are destroyed, and the development of gait is retarded or arrested at an immature level. It is hoped that this will eventually be investigated with force plates and electromyography. Natural physical compensation to loss of vision is thought to include, in its grossest form, neurological abnormalities; retention of primitive reactions; faulty postural reflexes; poor posture of a characteristic type; a consistent list of orthopedic deformities. It is outside the scope of this study to say in what percentage of blind people or in what types of subnormal vision these defects reach proportions troublesome enough to require treatment. Carroll (1) lists 20 functions of vision, for each of which he finds a different substitution. To replace vision's function as a component of locomotion, we will consider the long cane as a prosthesis, in order that compensation can be controlled and symptoms be permanently treated.

### PROSTHETIC USE OF THE LONG CANE

The long cane and its method of use were invented during the second world war by R. E. Hoover and associates at Valley Forge, U.S.A., to provide a means of safe independent travel for blinded ex-servicemen. Its use for this purpose has steadily increased since, and today in the U.S.A. these techniques form a major part of the science of peripatology, which is taught as a post-graduate course. This cane and its technique have been an aid to living, but its use as a prosthesis, or a piece of physical-medicine equipment, has, I believe, never been considered.

### THE LONG CANE

The long cane (Fig. 5) is in fact a walking stick, designed not for weight bearing but as a sensory tool. It is made of tapered bamboo or 7/16 in. diameter tubular rigid aluminum, with a small crook handle. Its length varies from say 42 in. for a 10-year-old beginner to 55 in. for a tall man expert in its use. Its weight should not exceed 6 oz., and its essential qualities are its lightness and conductivity of touch. Plastic or rubber tubing can be fitted just below the crook for the grip, and a replaceable rounded and very hard steel tip is screwed into the end. The surface and shape of this tip is engineered to slide over the ground with a minimum of catching. When held in the hand, the cane should always

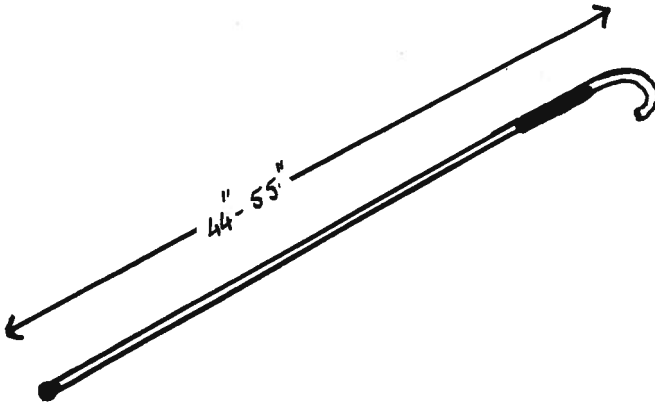


FIGURE 5.—The long cane.



FIGURE 6.—Foot and cane prints in the sand.

balance nicely. The cane is held lightly on the grip with the extended index finger lying along its length, so that it becomes an extension of the index finger. The hand is then dropped loosely to the side of the body and the tip is allowed to rest on the floor in front of the opposite foot. The crook is turned outwards over the knuckles to give protection. Properly measured, the cane tip now lies exactly one pace in front, on the spot where the foot will next fall. From this position the blind man walks forward, and when using the simplest indoor technique he slides the cane tip along the floor feeling its position and surface. For outdoor use or on rougher surfaces, the cane is held differently and is swung deftly from side to side so that it gently brushes the ground one pace ahead, on the spot where the foot will fall. The tracks of feet and cane on sand or soft gravel would appear as in Fig. 6.

The whole technique is described elsewhere (11); it is detailed, and covers almost foolproof reactions to every common situation. The training of a blind man in these techniques is the job of a specialist, who teaches independence with safety, a fact on which his pupil's life may depend. For the physiotherapist, a knowledge of the orientation and perceptual problems of the blind are important for success. Within the scope of physiotherapy

the long cane can become a prosthesis or valuable physical-medicine tool, for its construction and technique take (possibly naïvely) the mechanics of locomotion into account, a characteristic which no other guiding device has so far achieved. By involving only one hand, it contacts the ground without destroying normal posture. It should be noted in passing that this contact with the floor is an entirely different postural and reflex situation from tapping or touching the wall, holding another person, or—worse—being held by them; and that it is also mechanically different from using the feet for the double duty of receptor and effector. Prosthetically the cane replaces the three functions of vision. First, it supplies by contact with the ground one pace ahead (allowing sufficient reaction time for a person trained in its use), data concerning the timing of heel-strike, friction, gravity, slopes, holes, or cliffs. Second, it supplies additional postural feedback, because the point of ground contact is an extra point of reference and a source of postural stimuli. This action translates vision's postural information into the language of kinesthetic sense. Third, it gives protection from danger, which reduces anxiety and its repercussions to a minimum.

### **POSTURE AND GAIT TRAINING**

Since I completed the work for this study, Siegel and Turner (13) have published specific methods of postural training for the blind. They mention a great problem in training kinesthetic sense and balance—the problem of communication. For example, when training weight-shifting over the feet, what does “forward and back,” in relation to body position, mean to a blind person who has built up a faulty set of postural reflexes? What he feels may not even be correctly connected to words. But the long cane “speaks” the language of the haptic mind, as it relays feedback normally transmitted by vision. Once this is understood it is clear that this sensory cane is an asset to any chosen method of posture correction, for it registers, by ground contact, changes of body position, and amplifies a kinesthetic message. However, it was found that the best approach to postural training was neurological and of the type described by Barlow (6, 7) in which a total pattern of reaction is trained first, for he says that in postural training, what is required is not strengthening of muscles but integration of intention. Time was spent practicing purposeful walking between two given points, repeated again and again at greater speed. Gait training developed from this. Initiation of forward movement with forward and upward movement (opposite of retraction) of the head was taught, and this had an immediately beneficial effect on dynamic posture and the initiation of integrated action, for, from the motor point of view, it restored some degree of head dominance. As confidence and integration are achieved a relaxed gait pattern can be encouraged, for gradually the faulty coordina-

tions disappear and integration of reaction overcomes freezing, purposeless movement, and blindness. Where secondary deformity is present it requires concurrent treatment. It was my experience that in blind patients posture and gait correction failed consistently to gain permanent results until the long cane was used. In this study every case of posture correction was followed with some form of mobility training. The possible effects of this training on the development of children has been surveyed elsewhere (12) and it is not within the scope of this study to discuss the type of case for whom it could possibly be beneficial. But it is clear that if during posture training the improved gait has not become completely functional, i.e. if the subject, for the sake of safety, is forced to return to his bad old ways as soon as he gets into the street, no permanent postural improvement can be expected. In other words, the carryover should be observed.



FIGURE 7.—Accurate technique on a rough cracked surface, with relaxed easy posture.



FIGURE 8.—Confidence, relaxation, and good appearance in a dangerous situation.

## RESULTS AND CONCLUSION

Where vision is the missing component of a gait, the long cane used with the Hoover technique makes a valuable prosthesis for the reeducation of posture. Its use enables the blind person to maintain or reestablish the normal mechanics of gait, so that the undesirable orthopedic and neurological results of natural compensation to blindness can be prevented or treated (Fig. 7 and 8). The results obtained with the 16 subjects in this study were outstanding; in some cases the whole personality of the young person and his ability to function was changed. This is not an unwarranted claim if one believes, with Barlow, that posture is "a psychosomatic affair." A realistic view should be taken of the expected results of correction of posture and orthopedic deformity if either with or without a cane the improved gait cannot be functional and safe in every situation.

## REFERENCES

1. Carroll, Thomas J.: *Blindness: What it is, What it Does, and How to Live with it.* Little, Brown and Co., Boston, Massachusetts, 1961.

2. Anderson, M. H., C. O. Bechtol, and R. E. Sollars: *Clinical Prosthetics for Physicians and Therapists: A Handbook of Clinical Practices Related to Artificial Limbs*. Charles C Thomas, Springfield, Illinois, 1959.
3. Joseph, J.: The Activity of Some Muscles in Locomotion. *Physiotherapy* 50:180, 1964.
4. Barlow, W.: Anxiety and Muscle Tension, in *Modern Trends in Psychosomatic Medicine*. London, 1955.
5. Gesell, R. and C. S. Amatruda: *Developmental Diagnosis*. Paul B. Hoeber, Inc., New York, 1949.
6. Barlow, W.: Posture and Its Re-education, in *Therapeutic Exercise* (Sidney Licht, editor). Licht, New Haven, Connecticut 1958.
7. Barlow, W.: Psychosomatic Problems in Postural Re-education. *Lancet*, 2:659, 1955.
8. Gesell, R.: *The First Five Years of Life*. Methuen, London, 1954.
9. Lettin, A. W. F.: Orthopaedic Aspects of Gait, *Physiotherapy*, 50:188, 1964.
10. Hoover, R. E.: *Proceedings of First Rehabilitation Conference*. Royal Victorian Institute for the Blind, Melbourne, Australia, 1963.
11. *Instructions in Physical Orientation and Foot Travel*. The Industrial Home for the Blind, 57 Willoughby Street, Brooklyn, New York 11201.
12. Miller, J.: Mobility Training for Blind Children: Possible Effects of an Organized Mobility Program on the Growth and Development of a Blind Child. *New Outlook for the Blind*, 58(10):305-307, Dec. 1964.
13. Siegel, I. M. and M. Turner: Postural Training for the Blind, *Phys. Therapy*, 45(7):683-686, July 1965.